

G-b SHALE OIL PROJECT

BLM LIBRARY



88064908

BLM Library
D-553A, Building 50
Denver Federal Center
P. O. Box 25047
Denver, CO 80225-0047

OFFICE COPY
DO NOT REMOVE

NOV 23 1984

ATLANTIC RICHFIELD COMPANY
Operator

ASHLAND OIL, INCORPORATED
SHELL OIL COMPANY
THE OIL SHALE CORPORATION

April 15, 1975

INFORMATION PACKAGE

<u>CONTENTS:</u>	<u>PAGE NO.</u>
. BACKGROUND AND LOCATION	1
. SUMMARY OF ACTIVITIES	4
. PRE-EXPLORATION SURVEY	8
. CORE DRILLING AND GROUND WATER	10
. GROUND WATER MONITORING	13
. SURFACE WATER MONITORING	14
. AIR QUALITY	16
. VEGETATION STUDIES	21
. WILDLIFE STUDIES	22
. AQUATIC STUDIES	29
. ARCHAEOLOGICAL STUDIES	36
. OTHER	
. SOILS	36
. MICROENVIRONMENTAL	37
. FISH AND WILDLIFE MANAGEMENT	37
. SCENIC VALUES	38
. SURFACE GEOLOGY	38
. DENDROCHRONOLOGY	38
. REVEGETATION	39

BACKGROUND OF C-b SHALE OIL PROJECT

In February of 1974, a group of four companies, Ashland Oil, Incorporated, Atlantic Richfield Company, Shell Oil Company, and The Oil Shale Corporation, submitted the high bid for the second of the two Colorado Oil Shale Lease Tracts offered as part of the U.S. Department of Interior Prototype Federal Oil Shale Leasing Program. Atlantic Richfield Company is the Operator of this joint venture now called the C-b Shale Oil Project. The total bid was 117.8 million dollars to be paid in five annual payments.

The Federal Lease, which was signed by the C-b Shale Oil Project participants, requires that a Preliminary Development Plan, an Exploration Plan, and a Detailed Development Plan be submitted to the Federal Government for approval before full-scale mining or plant construction can begin on the C-b Tract. The Prototype Leasing Program is under the direction of the Area Oil Shale Supervisor of the U.S.G.S. Conservation Division, located in Grand Junction, Colorado. These Plans are also reviewed by the Oil Shale Environmental Advisory Panel, (OSEAP), which is comprised of Federal, State, County, and environmental representatives. All of these Plans must comply with detailed Environmental Stipulations which are part of the Lease. These Environmental Stipulations require the C-b Shale Oil Project to conduct two years of ecological baseline studies which include plant ecology, animal ecology, aquatic ecology, water quality and air quality. Plans to control erosion and revegetate processed shale disposal sites and other disturbed areas are required to be developed. A Fish and Wildlife Management Plan must also be submitted and approved. The Environmental Stipulations further require that, after

mining and processing activities are completed, the C-b Tract must be returned to a condition equivalent to its present state so that it can support the same kinds and number of animals that it does now.

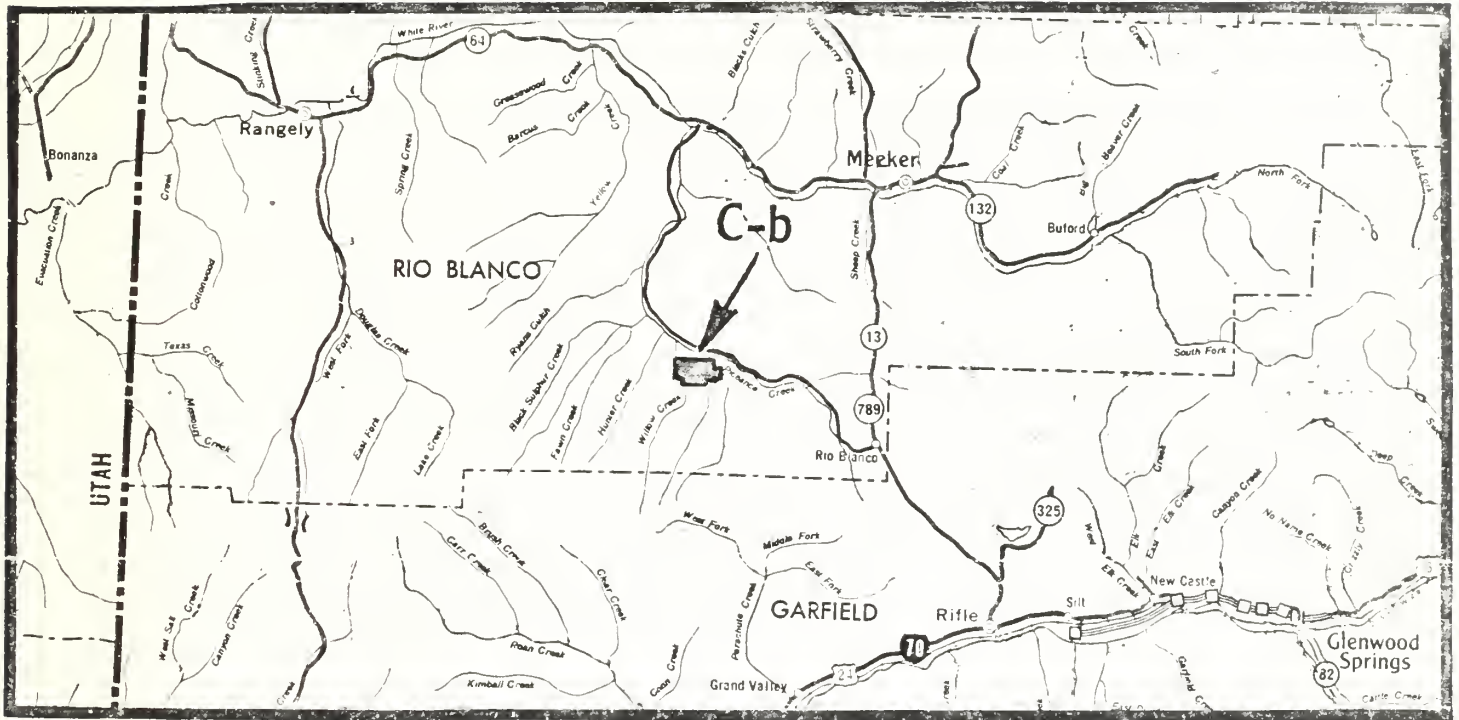
A Preliminary Development Plan was submitted to the Bureau of Land Management on March 6, 1974, shortly after award of the Lease. It describes tentative development plans and the types of activities that will be carried out and an approximate time schedule.

The Exploration Plan covering activities for approximately the first two years of the Lease has been submitted to the Area Oil Shale Supervisor, reviewed by the Government agencies and OSEAP and approved. This Exploration Plan covers the extensive environmental data collection programs and the exploration efforts planned to evaluate the oil shale reserves.

The Lease permits the C-b Shale Oil Project to submit the Detailed Development Plan (DDP) to the Area Oil Shale Supervisor after collection of ecological baseline data for one year. The DDP will incorporate the ecological data collected during the first year. It will describe, in more detail than the present Preliminary Development Plan, the proposed commercial development for Tract C-b. Environmental impacts resulting from construction and subsequent operation of these facilities will be analyzed to determine the steps that can be taken to reduce these impacts.

FIGURE 1

LOCATION OF TRACT C-b



Federal Oil Shale Lease Tract C-b (Figure 1) is located three miles south of the Piceance Creek Road at the PL Ranch turnoff which is 20 miles west of the Rio Blanco Store (half-way between Rifle and Meeker) on Colorado 13 and 789.

SUMMARY OF ACTIVITIES OCCURRING SINCE FEBRUARY, 1974

PRE-EXPLORATION PHASE ENVIRONMENTAL SURVEYS: Pre-exploration reconnaissance investigations encompassing plant ecology, animal ecology, aquatic ecology, and archaeology are done prior to the initiation of any disturbance on the Tract, (e.g., road improvement and core hole drilling). A team of plant and animal ecologists, and an archaeologist survey each site to be disturbed in order to: (1) determine what species are present, and if any of the areas are vital habitat for rare or endangered species; (2) develop a description of the plant communities present on the sites to aid in later rehabilitation; and (3) determine whether the area has any archaeological significance. A team of aquatic ecologists conducted similar investigations of the aquatic habitat prior to land disturbance in the vicinity of the Tract. Several activities were relocated as a result of the teams' recommendations.

DRILLING/MINING ENGINEERING: A series of core holes were drilled on Tract C-b to determine the extent and quality of the oil shale reserves and mining characteristics of the surrounding rock strata. Cores collected from the drilling have been subjected to various engineering or rock mechanics tests and have been assayed to determine their oil content. Data are also being collected on the quantity and quality of water present in the rock strata beneath the Tract. This information will be utilized to design the underground oil shale mine planned for Tract C-b.

ENVIRONMENTAL BASELINE STUDIES: The Environmental Stipulations of the Lease require the C-b Shale Oil Project to collect baseline data for one

year, prior to the submittal of a Detailed Development Plan for the C-b Tract. The various programs started between April - November of 1974 include:

1. Water Studies: The Lease Environmental Stipulations require a comprehensive surface and ground water data collection program. The surface water program consists of thirteen stream gauging stations installed on all drainages flowing onto and off Tract C-b. These stations measure flow, sediment, pH and salinity. Technicians from the U.S.G.S. Water Resources Division collect additional water quality samples twice a month for more detailed analysis. The ground water program is intimately associated with the exploratory drilling phase of the project. Core holes required for the mining and engineering have been completed as ground water observation wells. They are designed to monitor various subsurface aquifers on the Tract. Additional monitoring wells have been drilled along the stream valleys and gulches and near all proposed mining areas. Water quality samples have been collected and water level and quantity measurements taken during the drilling of each of these wells. Additional water quality samples and data will be collected from each of the completed wells every six months.

The Lessees also conducted a complex pumping test during the period from November, 1974 to April, 1975, to evaluate the hydraulic and water quality aspects of the ground water aquifers beneath the Tract.

By analyzing all of these surface water and ground water data, a water quality and quantity picture of the Tract C-b area prior to any development activities will be able to be prepared.

2. Air Quality Studies: The Lease Environmental Stipulations require that baseline air quality and meteorology be evaluated in order that potential impacts of commercial oil shale operations might be determined. In order to satisfy this requirement, Radian Corporation has been retained to install and operate monitoring equipment at five locations on the C-b Tract and along Piceance Creek. These monitoring stations are designed to obtain information in addition to that which is required by the Lease Stipulations.
3. Vegetation Studies: The vegetation study on Tract C-b is being carried out by Woodward-Clyde Environmental Consultants, their associated contractors, and by C-b Shale Oil Project staff personnel. Information being collected includes: types of vegetation and their occurrence (for instance, valley bottom sagebrush and pinyon-juniper); the use of certain species such as service berry, mountain mahogany, and bitterbrush by wildlife; natural changes now occurring in the vegetation types; identification of all species of plants; which plants are more common on the Tract; and the productivity of different species of plants. This information will allow us to properly plan the Tract development in such a way as to minimize adverse impact.
4. Wildlife Studies: Woodward-Clyde Consultants are studying the animals which occur on the Tract and its surrounding area.

The objective of these studies is to determine what kinds of animals live in this area, how many there are, and how they interact with one another, and how important Tract C-b is to these animals as compared to other parts of the Piceance Basin. Current studies include such activities as collecting insects; live-trapping and then releasing small mammals such as chipmunks and mice; studying predators (e.g., bobcat and coyotes) by signs and direct observations; observing songbirds, game birds, and birds of prey; counting big game (e.g., deer and elk) both from the ground and the air to determine patterns of migration and areas of heavy use; and studying the livestock use on the Tract area.

5. Aquatic Studies: Studies of animal life, plant life and water quality, in all waters which occur in the area surrounding Tract C-b and all streams draining the Tract as far downstream as the White River, are being conducted by Woodward-Clyde aquatic specialists. The objective of these studies is to determine the kinds and numbers of species existing in these waters, how productive the waters are, and how the aquatic system functions. These studies consist of activities such as collecting samples of insects and plants that live in or on the bottoms of these streams and ponds, electroshocking and then releasing fish, and taking samples of water for laboratory analysis of algae, bacteria and water quality.
6. Archaeology Studies: Consultants from Colorado State University have completed the fieldwork of a survey of Tract C-b for any

sites of archaeological, historic, or paleontological importance. No sites worthy of being included in the National Register of Historic Places were found. In addition to this baseline study, future studies will be done on any off-Tract areas which might be disturbed during activities such as road improvements or pipeline and powerline construction.

A list of all field activities and facilities currently on Tract C-b is given in Figure 2.

PRE-EXPLORATION ENVIRONMENTAL RECONNAISSANCE SURVEYS

All sites on which any ground disturbance has taken place as the result of exploration activities were surveyed prior to this disturbance.

The surveys included studies of:

1. plant ecology
2. animal ecology
3. archaeology

These surveys were performed in order to:

1. Insure that activities were not planned to take place in areas of significant habitat, vegetation, or archaeological areas; and
2. To provide information necessary to rehabilitate these disturbed areas after the completion of the exploration activities.

The aquatic habitat in the vicinity of the Tract was also surveyed prior to the initiation of any land disturbance.

The majority of the areas which were surveyed were found to be of no special significant in relation to the Tract as a whole. In several

FIGURE 2

TRACT C-B FIELD ACTIVITIES

- 13 SURFACE WATER GAUGING STATIONS
- 5 AIR QUALITY TRAILERS
- 1 200-FOOT METEOROLOGICAL TOWER
- 12 VEGETATION PLOTS
- 17 AQUATIC ECOLOGY SAMPLING STATIONS
- 11 PELLET-GROUP TRANSECTS
- 7 CORE HOLES
- 1 PUMP TEST WELL
- 4 PUMP TEST OBSERVATION WELLS
- 13 ALLUVIAL WELLS
- 2 PREDATOR SCENT-POST SURVEY LINES
- 2 PARASITE SAMPLING SITES
- 2 WATERFOWL SYSTEMATIC OBSERVATION SITES
- 5 ANIMAL TRACK COUNT TRANSECTS
- 2 ANIMAL TRAP SITES
- 8 SATELLITE ANIMAL TRAP SITES
- 8 ORNITHOLOGICAL STUDY TRANSECTS
- 4 MICROENVIRONMENTAL STATIONS

TRACT OFFICES

GUARD HOUSE

3 TRAILERS

POWERLINES

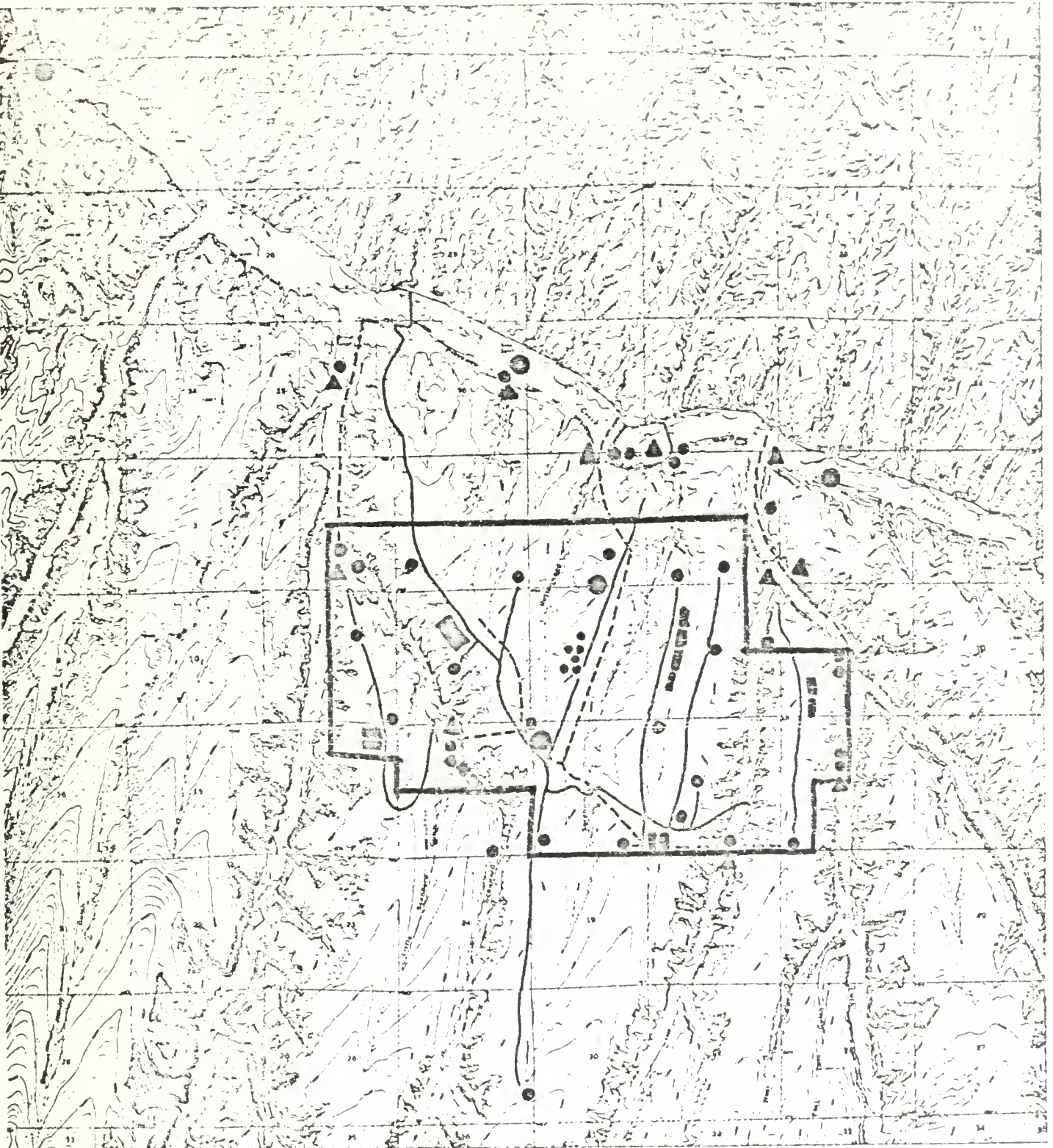
cases, however, the reconnaissance team made recommendations with regard to modifying the location, timing, or method of exploration work which was planned to be done, and these recommendations were followed prior to the initiation of the exploration work. The sites which were surveyed are depicted in Figure 3.

CORE DRILLING AND GROUND WATER

An extensive core drilling program was designed on Tract C-b to meet the requirements of the Environmental Stipulations as well as to evaluate the feasibility of underground mine construction from the standpoint of oil shale reserves and rock mechanics criteria. The locations of the various core holes and wells are depicted in Figure 4. All drilling shown on Figure 4 has been completed.

The Tract C-b Lessees have drilled a pump test well at the proposed mine site (AT-1) and completed observation wells in the two aquifers or water-bearing zones (above and below the Mahogany mining zone) and in the potential mining zone. Well AT-1C selectively monitors water in all three zones: upper aquifer, lower aquifer and mining zone.

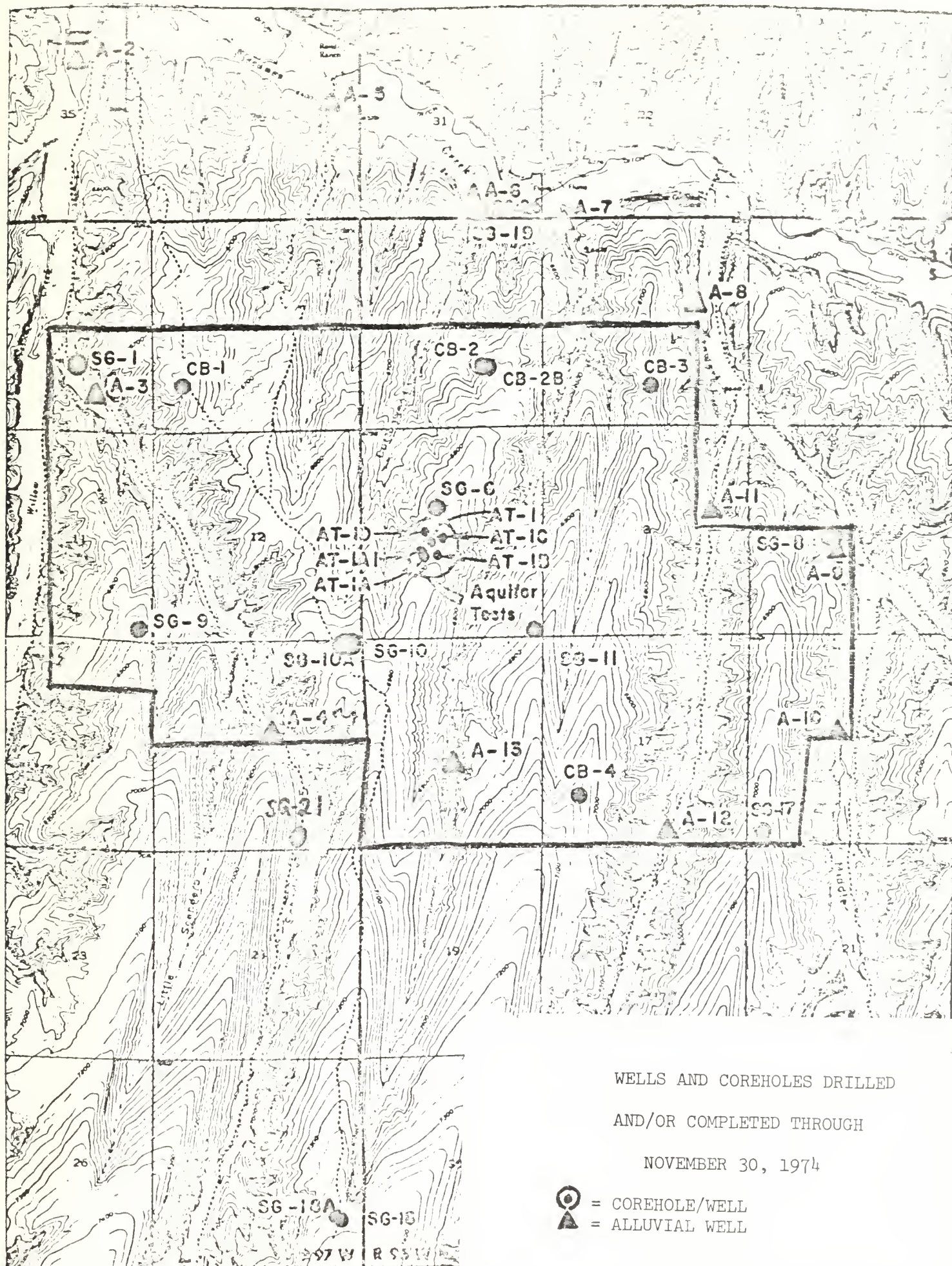
A pumping test in the upper aquifer was commenced on November 30, 1974 and terminated in mid-January, 1975. A second phase of the pumping test of AT-1 was then conducted in the lower aquifer and was completed in April, 1975. In addition to the Lease requirements, eight other drill holes were instrumented as observation wells for the pumping test to record water level response data at distances of 85 to 3236 feet from the test well AT-1. These data will be used in computer simulation and modelling of the aquifers for water management and mine design.



MAP OF PRE-EXPLORATION SURVEYS

- ROADS
- - - POWERLINES
- SUPPORT FACILITIES
- AIR QUALITY STATION
- CORE HOLES
- ▲ WATER GAUGING SITES
- BIOLOGICAL OBSERVATION PLOTS

FIGURE 4



Through April, 1975, a total of 7 deep core holes, 8 additional observation wells in the upper aquifer, 13 alluvial observation wells, and the pump test well AT-1 had been drilled. The data from wells or core holes drilled in addition to Lease requirements are being utilized for mine design purposes. Also, all of the core holes have been completed as ground water observation wells. Water level and water quality data are collected from these wells on a periodic basis, to supplement the ground water environmental program and will be used eventually for water management and mine design purposes. The following list summarizes the data collected from the core holes and wells.

- Pump Test Measurements
- Drilling Water Production Data
- Drilling Water Quality Analysis
- Baseline Water Quality
- Geophysical Log Data
- Lithological Logs
- Core Assay Data
- Core and Cuttings Trace Element Analysis
- Rock Mechanics
- Gas Determination and Analysis

GROUND WATER MONITORING

The Federal Oil Shale Lease Environmental Stipulations require:

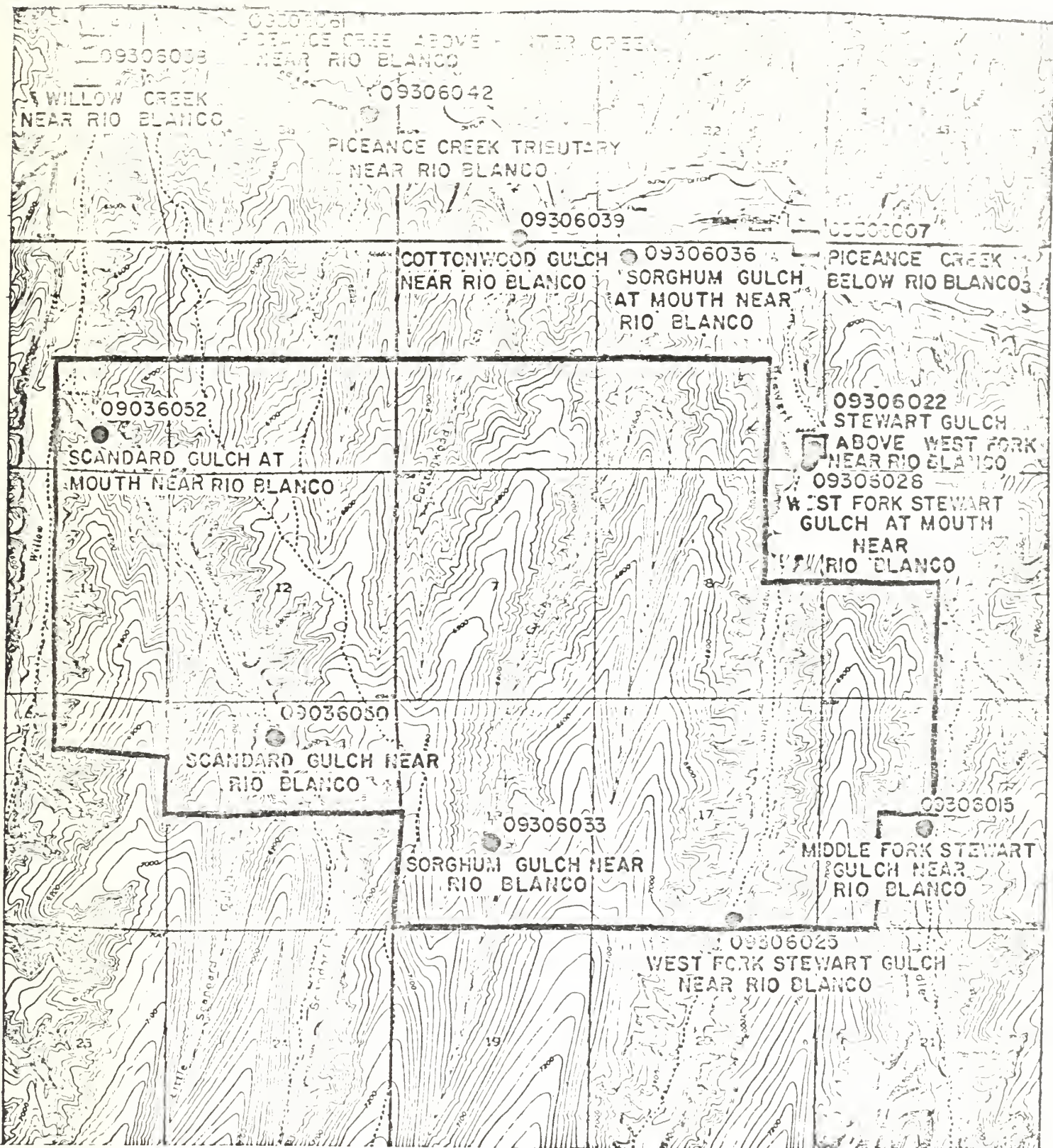
(1) a test well and observation well at each proposed or actual mine site; (2) a well upgradient from each spent shale disposal site; and (3) at least two observation wells downgradient from the disposal site. On Tract C-b, this results in a total of five wells being required by the Lease. The map (Figure 4) indicates the locations of these wells. AT-1 and 1-C are located at the proposed mine site; SG-18a is the observation well located upgradient of the proposed Sorghum Gulch spent shale disposal

site; and SG-19 and A-7 are the two wells downgradient of the proposed disposal area. All of these wells were completed and sampled for baseline purposes by November 1, 1974. Upper zone wells SG-20 and 21, the alluvial wells, and the core holes converted to ground water observation wells complete the baseline observation well program. Water quality samples are being collected from all of these observation wells at six month intervals during the two-year baseline period. The samples are being analyzed for all required constituents.

SURFACE WATER MONITORING

Thirteen stream gauging stations have been installed in the vicinity of Tract C-b. (Figure 5) Nine of the stations are located on ephemeral streams which flow only when a major precipitation event occurs. Four of the stations are considered major stations, and are located on the perennial drainages: two on Piceance Creek, one above and one below the Tract; one on Willow Creek; and one on Stewart Gulch.

The U.S.G.S. Office in Meeker maintains the stations and collects water samples every other week. At quarterly intervals, water samples are collected from the four major stations and analyzed according to a comprehensive schedule. Routine water samples from all stations are analyzed on a less complete schedule, although still comprehensive by most standards. This program was begun in late April, 1974. Since then, several changes were incorporated into the program. Final approval for the program was received from the Area Oil Shale Supervisor in August, 1974. This approval called for the installation of turbidity monitors on Piceance Creek, continuous dissolved oxygen, and pH monitors on the four major stations. By November, all of the required monitors had been installed and the stations powered with electricity.



U.S.G.S. SURFACE WATER GAUGING STATIONS



Stations on perennial streams



Stations on ephemeral streams

AIR QUALITY

The Tract C-b Air Quality Program is concerned with both measurements of atmospheric constituents and meteorological processes which affect their transport and diffusion. Experimental program areas include air quality and surface meteorology, low-altitude meteorology, upper air studies and visibility. In addition, predictive modelling studies will be conducted to evaluate the effects of commercial operations on ambient air quality. A summary of the data being collected in the experimental programs is provided in Tables 1 and 2.

Air Quality and Surface Meteorology

The Oil Shale Lease Environmental Stipulations require monitoring of air quality data over at least 90% of the Lease year at four stations, one of which is at (or as near as practicable) the expected point of maximum concentrations. Sulfur dioxide, hydrogen sulfide, and suspended particulates are required to be monitored at all stations.

Hydrocarbons, oxides of nitrogen, ozones and carbon monoxide are also required to be monitored as directed by the Area Oil Shale Supervisor. Figure 6 is a map indicating the locations of five air quality trailers and the meteorological tower. Trailers 020, 021, and 022 are located in the Piceance Creek Basin at Redd Ranch, Rock School and the Gerald Oldland Ranch, respectively; trailers 023 and 024 are on the Tract at the meteorological tower and on the ridge between Cottonwood and Sorghum Gulches, respectively. The trailers and meteorological tower were designed by Radian Corporation of Austin, Texas and are being operated and maintained by Radian personnel.

TABLE 2

C-b AIR QUALITY & METEOROLOGY SAMPLING FREQUENCY
& MIN. AVERAGING TIMES

Symbols Appear on Table 1

Symbol	Sampling Frequency	Min. Average Time Or Report Frequency	Description
X	1/sec.	5 min. average	AQ & Low Alt. Met.
Y	5 min.	5 min.	
O	24 Hr. Samples	Daily	Particulate concentrations from fiberglass filters
	24 Hr. Samples	Quarterly cumulative	Frequency distribution of particulate concentrations
	24 Hr. Samples	Every 6 days per quarter	Particulate trace elements and radioactivity from one typical cellulose filter collected
		Quarterly cumulative	Composite of all the cellulose filters collected over the quarter
	1 Quarter	Quarterly	Volatile trace metals (Hg, Se, As) by chemical analysis and particle size distributions
1	1/sec.	5 min. average	Temp. difference between 30' and 100' height on met. tower
2	1/sec.	5 min. average	Temp. difference between 30' and 200' height on met. tower
+	1/sec.	Daily max. and min. times	Barometric Pressure
*	At least 2/day for 15 day/quarter	Same	High alt. meteorology temp. & wind profiles to 6000 ft.
&	1/14-sec.	Onset & extent of inversions	Acoustic echo (for temp. inversions)

Trailers 020 through 023 became operational in September, 1974; trailer 024 became operational in October, 1974. Thus, the required air quality monitoring system was completely operational as of November 1, 1974.

Low Altitude Meteorology

Complex near-surface wind patterns vary with elevation above the surface. To assess this vertical variation, a 200-foot meteorological tower has been installed at the site indicated on Figure 6.

The Oil Shale Lease Environmental Stipulations require a meteorological tower to be established in reasonable proximity to the proposed plant site. Low altitude meteorological tower data are obtained at 8, 30, 100 and 200 feet for wind direction and speed, relative humidity, and temperature. Barometric pressure and daytime solar radiation are obtained at ground level. Temperature differences are obtained between the 30 and 100 foot levels and between the 30 and 200 foot levels as part of an integrated approach toward determination of atmospheric stability.

Upper Air Studies

The purpose of the upper air studies is to obtain wind and temperature profiles from altitudes above the meteorological tower to approximately 6,000 feet above the surface. Furthermore, from knowledge of the changes in the variation in temperature with increasing altitude (called the lapse rate), insights into atmospheric stability are obtained. Cases where air temperature increase with height are called inversions, resulting in a layer of extreme stability; inversions lead to slow dispersion of gaseous constituents.

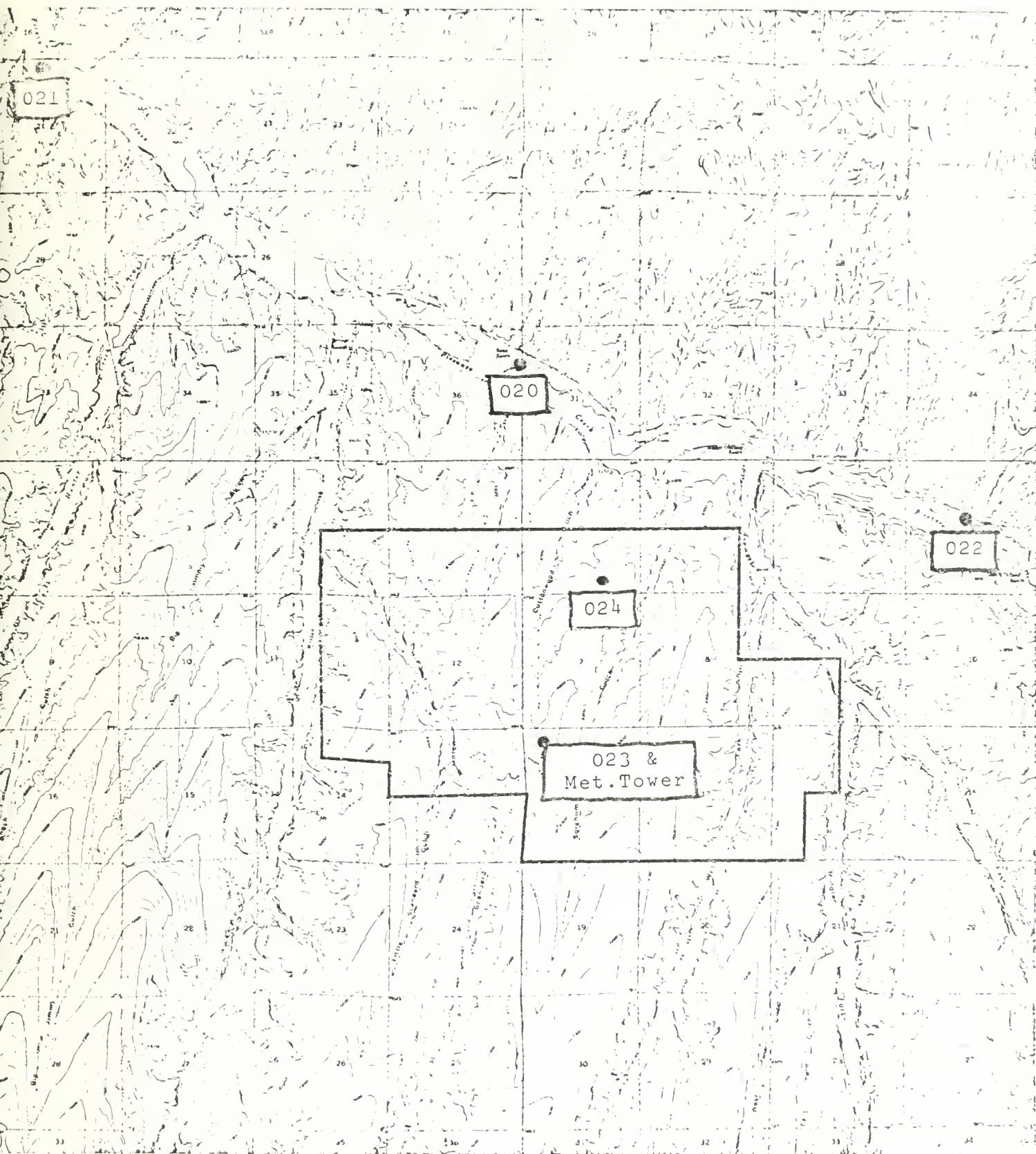


FIGURE 6 --- AIR QUALITY & METEOROLOGICAL STATION LOCATIONS

The air quality program Conditions for Approval from the Area Oil Shale Supervisor require two winds aloft and temperature profiles per day to altitudes of 6000 feet above the Tract for a minimum of 15 days per quarter. Winds aloft obtained from pibal releases at the meteorological tower; temperature aloft are obtained via an instrumented aircraft.

In addition to the above instrumentation, an acoustic sounder was installed at the meteorological tower location by Marlatt and Associates, on December 7, 1974 and became operational as of January 2, 1975. It will be used to further assist in assessing atmospheric stability by determination of the height and time-extent of unstable layers and stable layers, including inversions.

Visibility

Site visibility measurements are also required in the Conditions for Approval by the Area Oil Shale Supervisor. A proposal for these studies has been submitted for approval.

Atmospheric Diffusion Studies

Conditions for Approval from the Area Oil Shale Supervisor require ground level concentration estimates for 24-hour and 3-hour averages. These studies will be initiated at a future date when stack emission data become available.

VEGETATION STUDIES

Vegetation studies are designed to develop information about plant community structure and function. In order to gather this information,

permanent plots (Figure 7) were designed and established in each of the four major vegetation types; namely, chained Pinyon-Juniper, Pinyon-Juniper, Valley Bottom Sagebrush, and Plateau Sagebrush. These plots will be observed throughout the two year baseline period, and monitored during the development of the Tract. The plots have been set up in pairs. Each pair consists of one open plot and one fenced plot designed to exclude deer and livestock. This allows a comparison of plant use by large mammals.

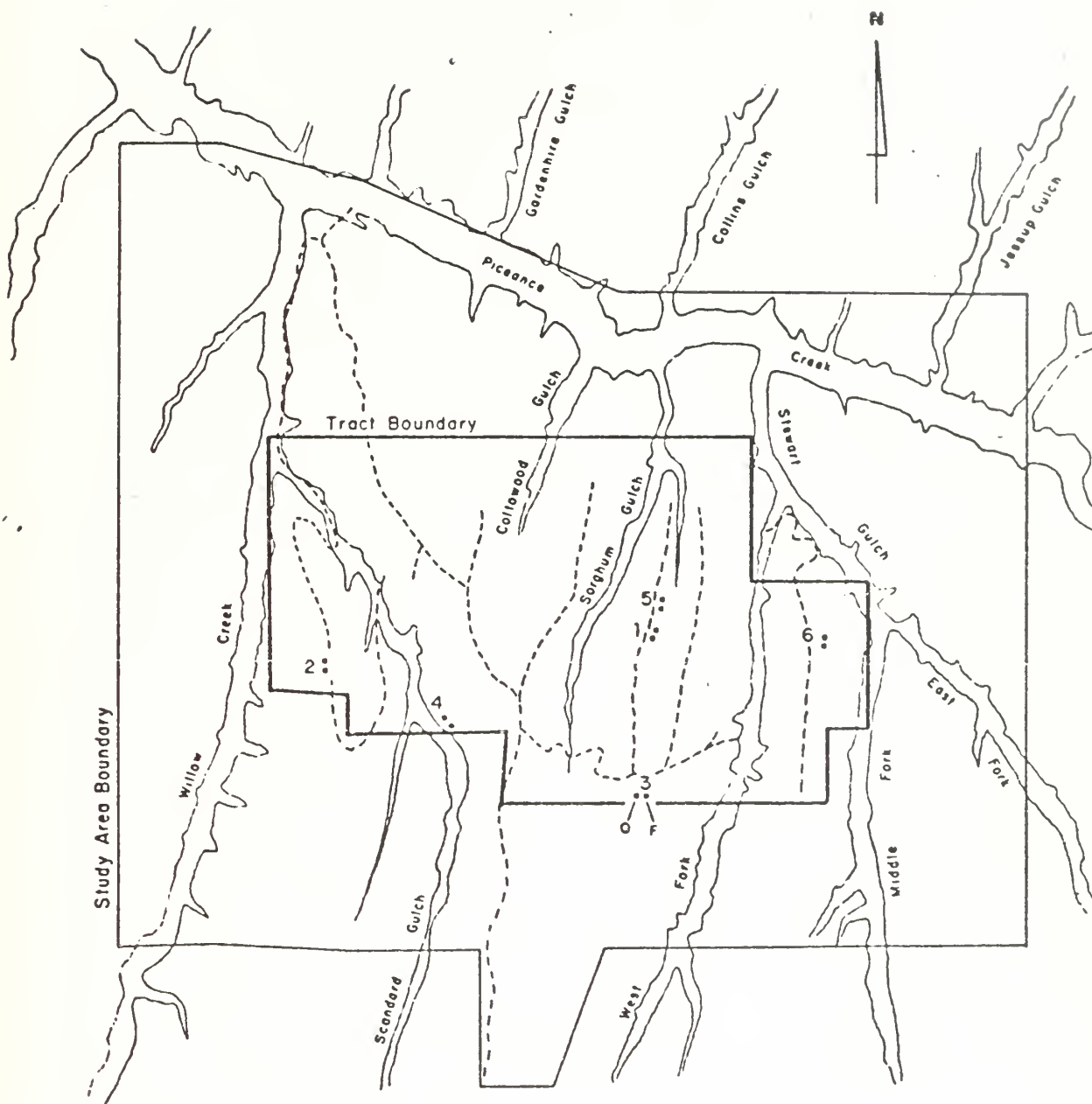
The vegetation characteristics (Table 3) being measured in these plots include: the kinds of plants, their abundance, occurrence, productivity, decomposition, and development during the season. Total coverage of the surface by plants, rock, soil, and litter is also being studied within these plots.

Additional work being conducted outside the plots include: studies of vegetation trends, vegetation mapping, additional study of plant development during the growing season, and collection of plant species for identification and record.

WILDLIFE STUDIES

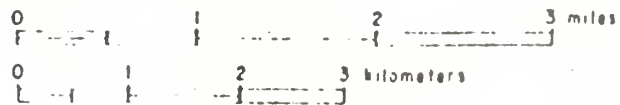
The wildlife baseline program was designed so that it, together with the flora studies, soil studies, microclimatology studies, and others, would give a description of not only what species are present, but also would provide an understanding of the total ecological system. As such, all groups of animals are included in the faunal studies and all vegetation studies are coordinated with the faunal studies.

FIGURE 7



KEY:

- 1 : CHAINED PINYON-JUNIPER (EXPERIMENTAL)
- 2 : CHAINED PINYON-JUNIPER (CONTROL)
- 3 : PLATEAU SAGEBRUSH
- 4 : VALLEY SAGEBRUSH
- 5 : PINYON - JUNIPER (EXPERIMENTAL)
- 6 : PINYON - JUNIPER (CONTROL)



VEGETATION STUDY AREAS

TABLE 3

DATA COLLECTED FROM PERMANENT VEGETATION PLOTS

TRACT C-b

<u>TREES:</u>	<u>PRODUCTIVITY STUDIES:</u>
TREE SPECIES PRESENT	GROWTH RATE OF HERBACEOUS SPECIES
DIAMETER AT BREAST HEIGHT	GROWTH RATE OF WOODY SPECIES
HEIGHT	
COVER BY LEAFY CANOPY	
<u>HERB QUADRATS:</u>	<u>DECOMPOSITION STUDIES:</u>
HERBACEOUS SPECIES PRESENT	RATE OF BREAKDOWN OF LEAVES OF MAJOR
WOODY SPECIES PRESENT (SMALLER THAN	SIRUB SPECIES
25 CM HIGH)	RATE OF LITTER FALL SUPPLYING PLANT
COVER BY HERBACEOUS AND WOODY PLANTS,	MATERIAL TO DECOMPOSERS
BY MOSSES AND LICHENS AND BY OTHER	
MATERIALS: ROCK, SOIL & LITTER	<u>PHENOLOGICAL STUDIES:</u>
<u>SIRUB BELT TRANSECTS:</u>	GRAPHIC REPRESENTATION OF TAGGED SIRUBS
WOODY SPECIES PRESENT (LARGER THAN	VIGOR OF SIRUBS
25 CM HIGH)	PRESENCE OR ABSENCE OF INSECT FALLS ON
COVER BY WOODY SPECIES	SIRUBS
NUMBERS OF INDIVIDUALS OF EACH	TWIG MEASUREMENTS: LENGTH, NUMBER OF LEAVES,
SPECIES BY HEIGHT CLASS	NUMBER OF BUDS
	FLOWERING
	SEED SET
	BEGINNING OF THE PHOTOSYNTHETIC PERIOD

The major groups which are being studied along with the methods of study and type of data being collected, are shown in Table 4. The locations of the intensive sampling programs are illustrated in Figures 8 and 9. Big game pellet group and browse utilization transects are located in representative areas throughout the Tract. Big game and medium mammal track count transects are located along roads and streambeds in suitable substrate areas around the Tract. Predator scent post survey transects are located in suitable substrate areas along roads near the Tract. Small mammal intensive live-trapping grids are located in the two major habitat types present on the Tract, chained pinyon-juniper and unchained pinyon-juniper. Small mammal satellite live-trapping grids are located in all other representative ridge and gulch types of the Tract. Ornithological strip transects are located in all representative habitat types on and around the Tract. Waterfowl systematic observation locations are located on representative ponds. Owl transects are located along roads on and near the Tract. Reptile, amphibian, and ground arthropod pit-can grids are located in the major small mammal live-trapping grids.

In addition to these intensive study programs; the consultant is undertaking the following studies:

1. Conducting aerial flights and road counts for big game;
2. A survey for medium-sized mammals involving observation, live-trapping and identification of signs;
3. Studies of predator-prey relationships;
4. Observations of raptors and a survey of their nest locations;
5. An observational survey of amphibians;
6. Sweep-netting programs of representative plants for arthropods; and
7. Soil samples for arthropods in all major vegetative associations.

TABLE 4

WILDLIFE GROUPS

METHODS OF STUDYTYPE OF DATALARGE MAMMALS

AERIAL AND ROAD COUNTS
 PELLET GROUP COUNTS
 TRACK COUNTS
 WINTER MORTALITY STUDY
 PLANT UTILIZATION STUDY
 BIG GAME/LIVESTOCK COMPETITION

SPECIES, ABUNDANCE, DISTRIBUTION
 MOVEMENT PATTERNS, AGE CLASSES,
 SEX RATIOS, HABITAT USE, BROWSE
 EVALUATION

MEDIUM MAMMALS, PREDATORS, RARE OR
ENDANGERED SPECIES

TRACK COUNTS
 SCENT POST SURVEY
 OBSERVE, LIVE-TRAP, SIGN
 IDENTIFICATION
 SCAT ANALYSIS, PREDATOR-PREY
 STUDY

SPECIES, RELATIVE ABUNDANCE,
 DISTRIBUTION, HABITAT UTILIZATION,
 PREDATOR FOOD SOURCES

SMALL MAMMALS

MARK-AND-RECAPTURE LIVE-TRAPPING SPECIES, NUMBERS, DISTRIBUTION,
 QUALITATIVE LIVE-TRAPPING SEX, AGE, BIOMASS, DYNAMICS

AVIFAUNA

EMLEN STRIP TRANSECTS
 OBSERVE, SIGN IDENTIFICATION
 (SONGBIRDS)
 SYSTEMATIC WATERFOWL OBSERVATION
 RAPTOR OBSERVATION
 RAPTOR NEST AND BREEDING PAIR
 STUDY
 OWL TRANSECTS

SPECIES, DENSITY, DISTRIBUTION,
 STATUS, MOVEMENT PATTERNS, HABITAT
 UTILIZATION, AGE CLASS, NEST
 LOCATIONS

REPTILES AND AMPHIBIANS

PIT CAN TRAPPING GRIDS
 OBSERVATION

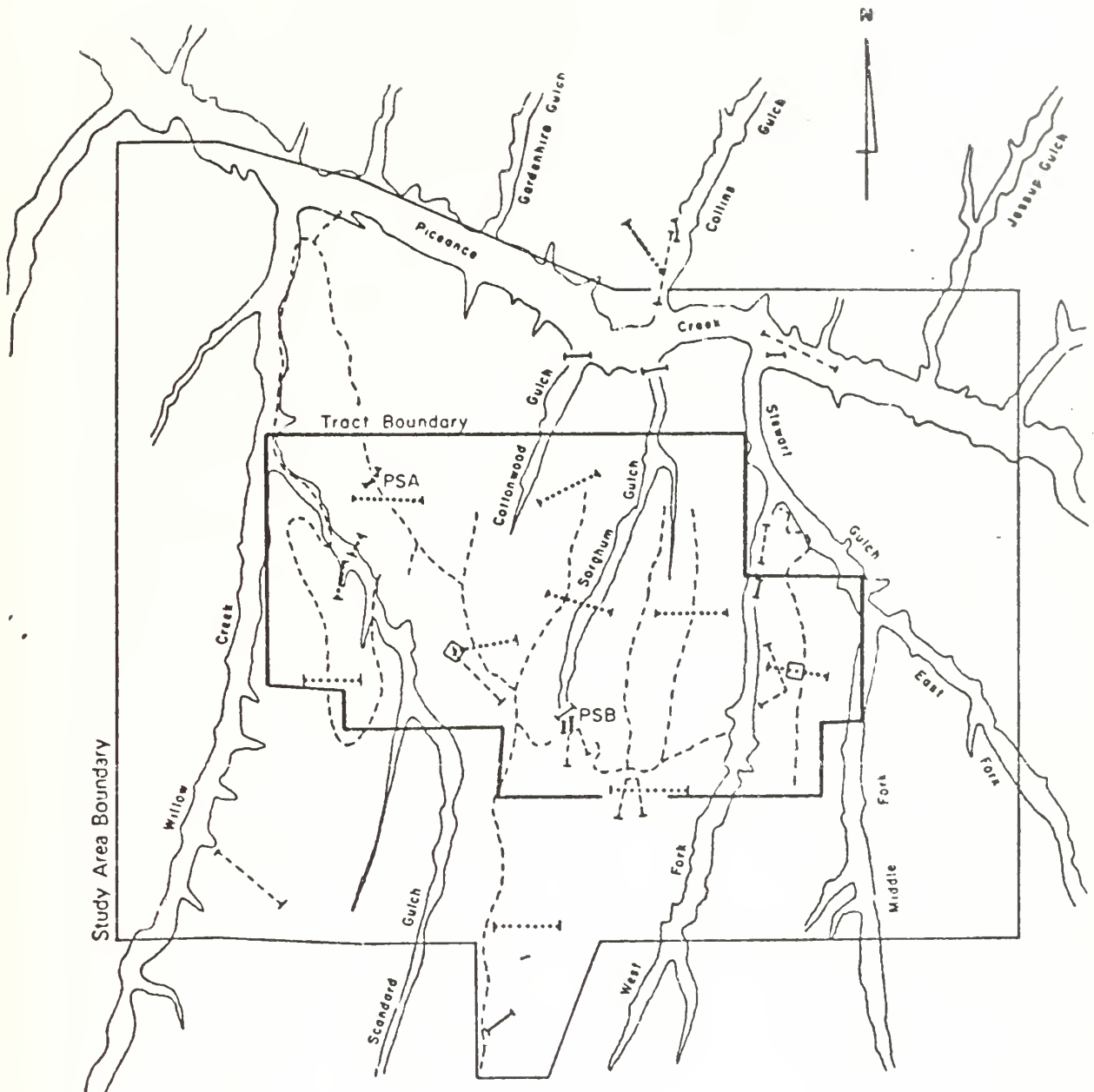
SPECIES, RELATIVE ABUNDANCE,
 DISTRIBUTION

ARTHROPODS

PIT CAN TRAPPING GRIDS
 SWEEP NETTING
 SOIL SAMPLING

SPECIES OR GROUP, ABUNDANCE,
 SEASONAL DISTRIBUTION,
 FUNCTIONAL CATEGORY

FIGURE 8



KEY:

PSA = Parasite sample - A

PSB = Parasite sample - B

— = Roads

--- = Ornithological study transect

— = Satellite animal trapping transect

— = Small mammal parasite sampling site

..... = Deer pellet and browse transect

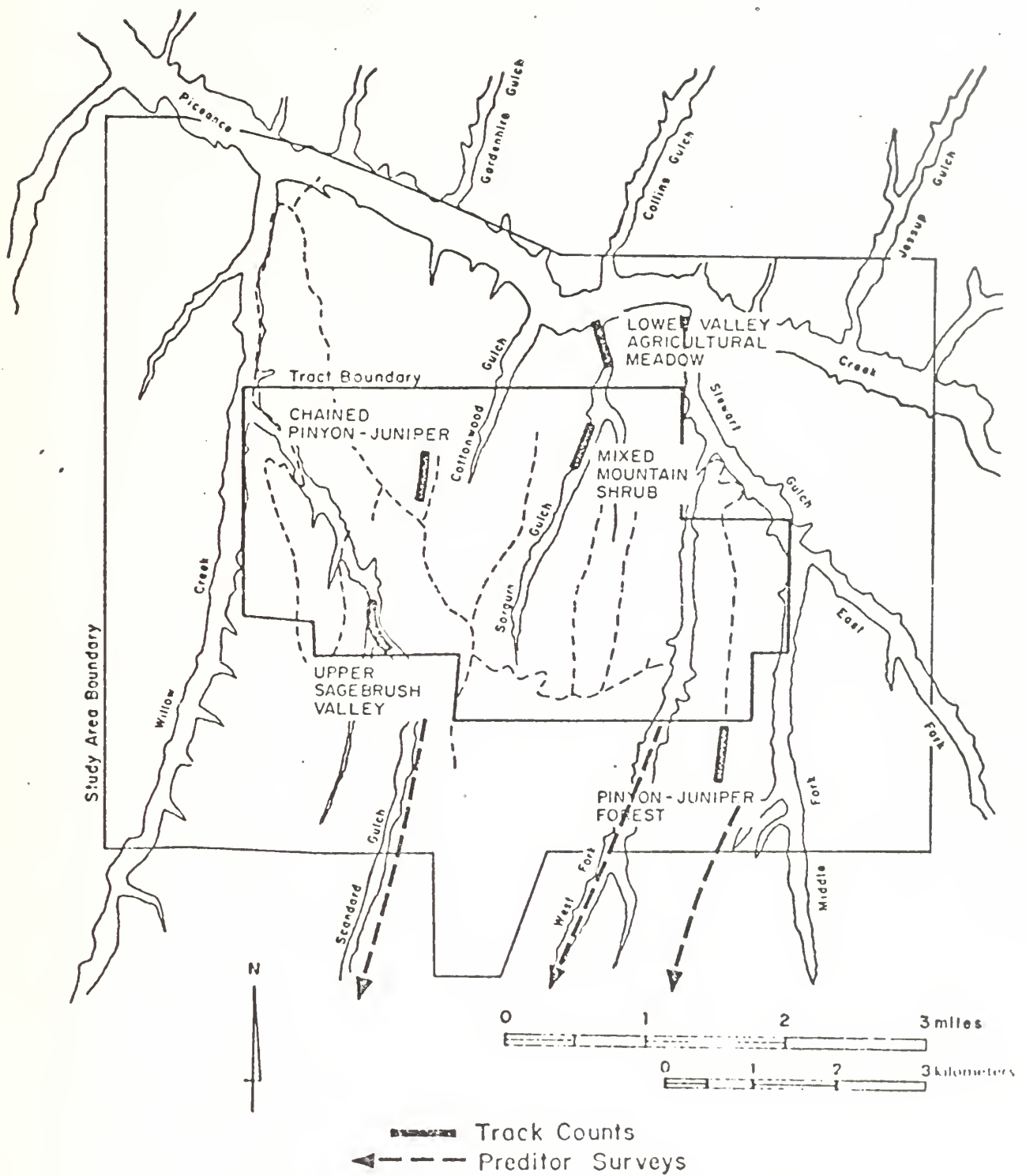
□ = Small mammal trapping grid, reptile and arthropod pit cans.

0 1 2 3 miles

0 1 2 3 kilometers

TERRESTRIAL WILDLIFE STUDY AREAS

FIGURE 9



LOCATION OF TRACK COUNT TRANSECTS AND
PREDATOR SURVEY LINES

At this time, available data from these study programs are quite preliminary and inconclusive, especially in the quantitative area. Qualitatively, however, Figure 10 illustrates what we tentatively believe to be the major functional relationships present in the Tract C-b area, based on the analysis of our data to date. Table 5 lists those wildlife species identified on or around Tract C-b.

AQUATIC STUDIES

The aquatic baseline program will study all classes of aquatic organisms present. The locations presently being sampled are shown in Figure 11.

These include:

1. The flowing streams (Willow and Stewart Creeks) in the Tract area;
2. The identified springs and seeps within a mile of the Tract boundary;
3. Locations on Piceance Creek in the immediate Tract area as well as downstream; and
4. Two selected locations on the White River, one upstream of Piceance Creek and one downstream.

The major groups in the aquatic system which are being studied, along with the methods of study and the type of data which are being collected in each case are shown in Table 6. Preliminary data suggest that:

1. Habitat varies along Piceance Creek, and fish abundance reflects habitat suitability;
2. Benthic samples show a high production of fish food in upper Stewart and Willow Creeks, with poorer species com-

FIGURE 10

MAJOR FUNCTIONAL RELATIONSHIPS

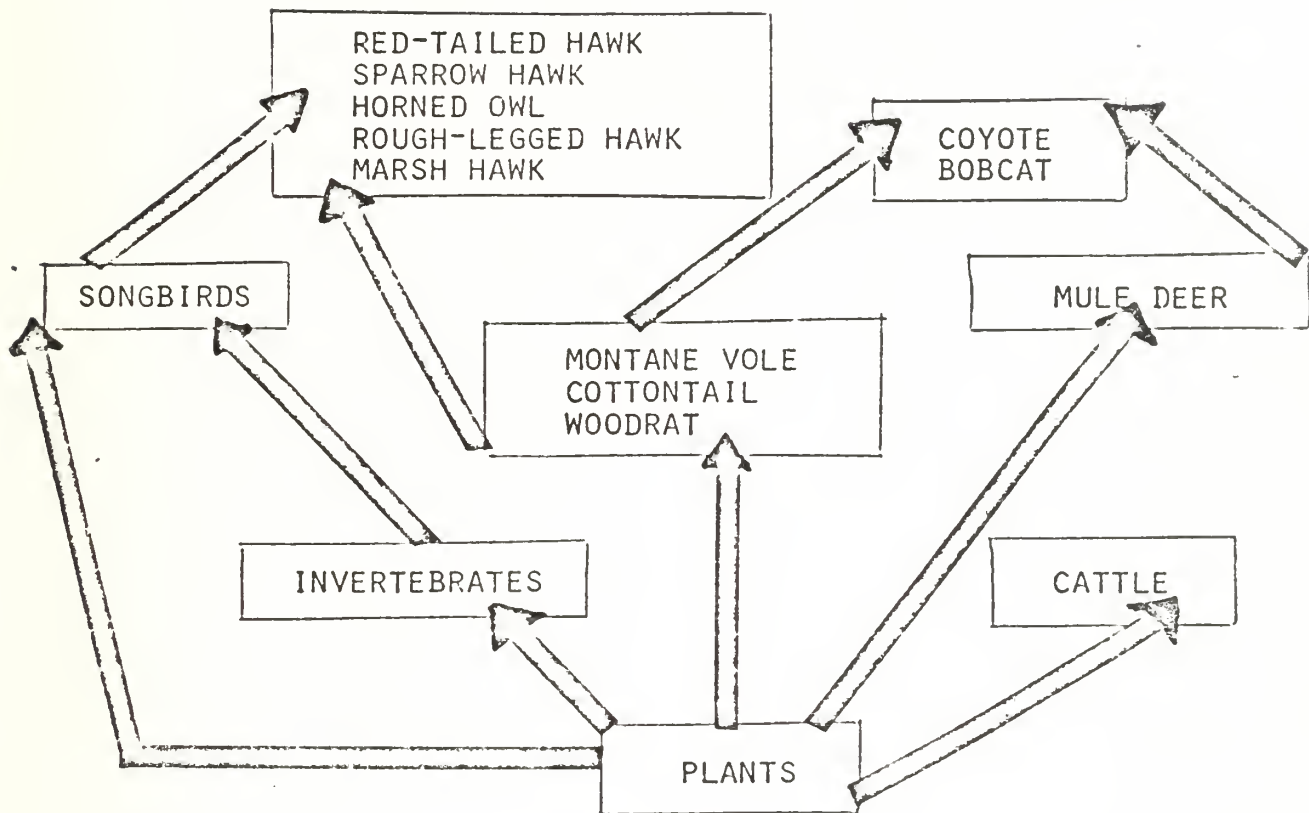


TABLE 5

MAMMALS* PRESENT ON OR AROUND TRACT C-b

Scientific Name	Common Name
<u>Canis latrans</u>	Coyote
<u>Castor canadensis</u>	Beaver
<u>Cervus canadensis</u>	Elk
<u>Erethizon dorsatum</u>	Porcupine
<u>Eutamias minimus</u>	Least chipmunk
<u>Eutamias quadrivittatus</u>	Colorado chipmunk
<u>Eutamias umbrinus</u>	Uinta chipmunk
<u>Lagurus curtatus</u>	Sagebrush vole
<u>Lepus townsendii</u>	White-tailed jack rabbit
<u>Lynx rufus</u>	Bobcat
<u>Marmota flaviventris</u>	Yellow-bellied marmot
<u>Mephitis mephitis</u>	Striped skunk
<u>Microtus montanus</u>	Montane vole
<u>Microtus pennsylvanicus</u>	Meadow vole
<u>Mustela erminea</u>	Ermine
<u>Mustela frenata</u>	Long-tailed weasel
<u>Neotoma cinerea</u>	Bushy-tailed wood rat
<u>Odocoileus hemionus</u>	Mule deer
<u>Ondatra zibethicus</u>	Muskrat
<u>Perognathus apache</u>	Apache pocket mouse
<u>Peromyscus maniculatus</u>	Deer mouse
<u>Procyon lotor</u>	Raccoon
<u>Sorex cinerea</u>	Masked shrew
<u>Sorex vagrans</u>	Vagrant shrew
<u>Spermophilus lateralis</u>	Golden-mantled ground squirrel
<u>Spermophilus tridecemlineatus</u>	Thirteen-lined ground squirrel

*Identified by sighting, live-trap, sign, etc.

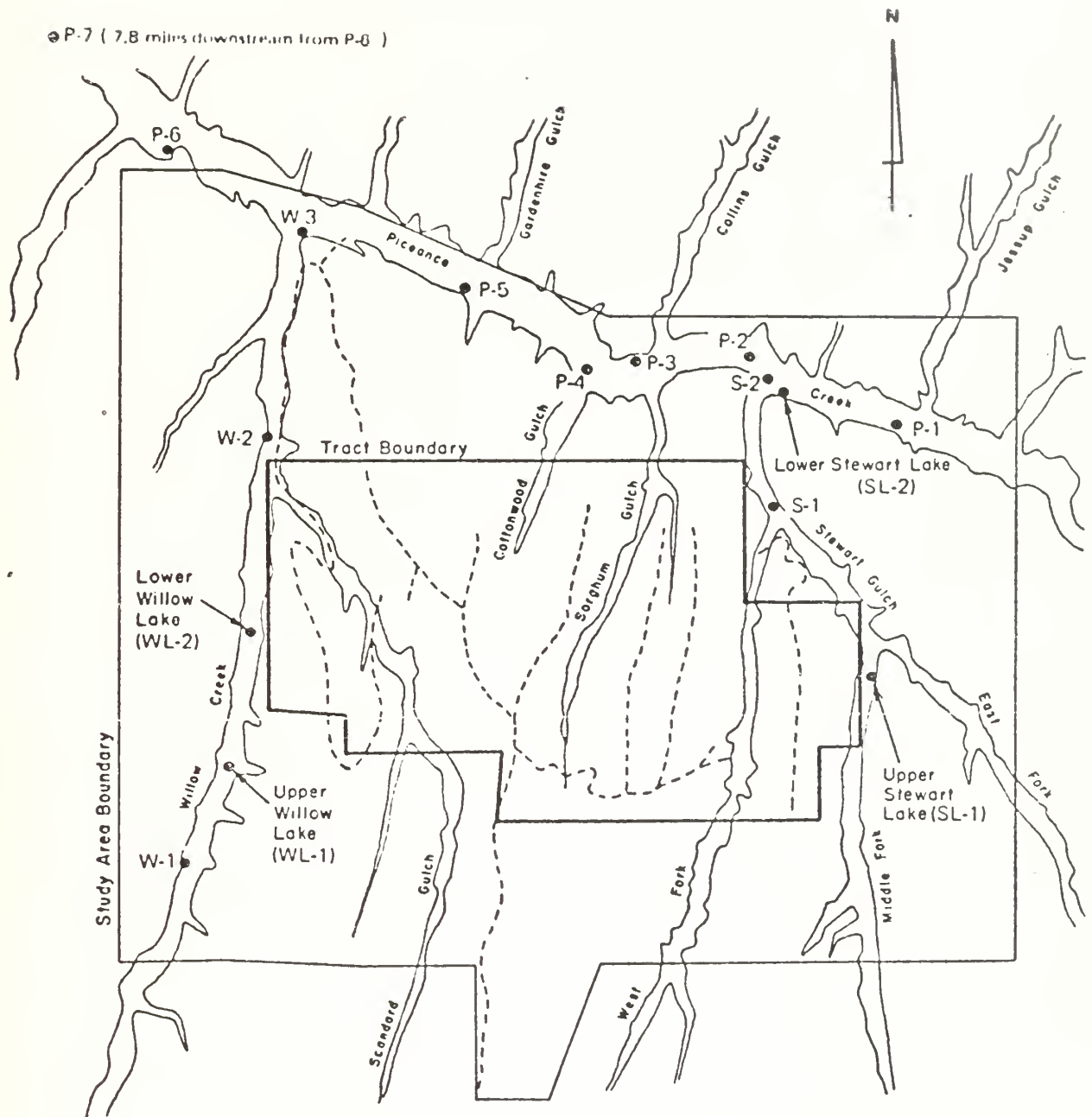
Table 5 Cont. SPECIES OF BIRDS OBSERVED DURING FALL FIELD INVESTIGATIONS
AT TRACT C-b

Scientific Name	Common Name
<u>Anas platyrhynchos</u>	Mallard
<u>Anas strepera</u>	Gadwall
<u>Anas crecca</u>	Green-winged teal
<u>Anas discors</u>	Blue-winged teal
<u>Anas americana</u>	American widgeon
<u>Anas clypeata</u>	Northern shoveler
<u>Buteo jamaicensis</u>	Red-tailed hawk
<u>Buteo lagopus</u>	Rough-legged hawk
<u>Aquila chrysaetos</u>	Golden eagle
<u>Circus cyaneus</u>	Marsh hawk
<u>Falco sparverius</u>	American kestrel
<u>Fulica americana</u>	American coot
<u>Zenaida macroura</u>	Mourning dove
<u>Tyto alba</u>	Barn owl
<u>Otus asio</u>	Screech owl
<u>Bubo virginianus</u>	Great horned owl
<u>Asio otus</u>	Long-eared owl
<u>Colaptes auratus</u>	Common flicker
<u>Dendrocopos villosus</u>	Hairy woodpecker
<u>Empidonax difficilis</u>	Western flycatcher
<u>Eremophila alpestris</u>	Horned lark
<u>Hirundo rustica</u>	Barn swallow
<u>Petrochelidon pyrrhonota</u>	Cliff swallow
<u>Cyanocitta stelleri</u>	Steller's jay
<u>Aphelocoma coerulescens</u>	Scrub jay
<u>Gymnorhinus cyanocephalus</u>	Pinyon jay
<u>Pica pica</u>	Black-billed magpie
<u>Corvus corax</u>	Common raven

Table 5 (Concluded)

Scientific Name	Common Name
<u>Corvus brachyrhynchos</u>	Common crow
<u>Nucifraga columbiana</u>	Clark's nutcracker
<u>Parus atricapillus</u>	Black-capped chickadee
<u>Parus gambeli</u>	Mountain chickadee
<u>Sitta carolinensis</u>	White-breasted nuthatch
<u>Sitta canadensis</u>	Red-breasted nuthatch
<u>Troglodytes aedon</u>	House wren
<u>Catherpes mexicanus</u>	Canyon wren
<u>Salpinctes obsoletus</u>	Rock wren
<u>Oreoscoptes montanus</u>	Sage thrasher
<u>Turdus migratorius</u>	American robin
<u>Sialia currucoides</u>	Mountain bluebird
<u>Myadestes townsendi</u>	Townsend's solitaire
<u>Regulus calendula</u>	Ruby-crowned kinglet
<u>Lanius excubitor</u>	Northern shrike
<u>Sturnus vulgaris</u>	Starling
<u>Dendroica coronata</u>	Yellow-rumped warbler
<u>Strumella neglecta</u>	Western meadowlark
<u>Agelaius phoeniceus</u>	Red-winged blackbird
<u>Euphagus cyanocephalus</u>	Brewer's blackbird
<u>Carpodacus mexicanus</u>	House finch
<u>Spinus pinus</u>	Pine siskin
<u>Spinus tristis</u>	American goldfinch
<u>Passerculus sandwichensis</u>	Savannah sparrow
<u>Poocetes gramineus</u>	Vesper sparrow
<u>Junco caniceps</u>	Gray-headed junco
<u>Spizella arborea</u>	Tree sparrow
<u>Zonotrichia leucophrys</u>	White-crowned sparrow
<u>Melospiza melodia</u>	Song sparrow

FIGURE 11
AQUATIC SAMPLING STATIONS



NOTE

Piceance Creek sites (P-1 thru P-7)

Willow Creek sites (W-1 thru W-3)

Stewart Creek sites (S-1, S-2)

- - - = Roads

TABLE 6

MAJOR AQUATIC GROUPS STUDIED

<u>METHODS OF STUDY</u>	<u>TYPE OF DATA</u>
<u>FISH</u>	
SEINE/ELECTROSHOCK, MARK AND RECAPTURE	SPECIES, ABUNDANCE, MOVEMENT PATTERNS
<u>BENTHOS</u>	
SURBER SAMPLING	GENERA, SPECIES NUMBERS, BIOMASS, DIVERSITY
<u>PERIPHYTON</u>	
DIATOMETER SAMPLING VASCULAR PLANT STUDY	GENERA, BIOMASS, VASCULAR PLANT SPECIES
<u>PLANKTON</u>	
FILTERED WATER SAMPLES	GROUP, BIOMASS, GROSS/NET PHOTOSYNTHESIS
<u>PRODUCTIVITY</u>	
LIGHT/DARK BOTTLE STUDY	PRIMARY PRODUCTIVITY
<u>WATER QUALITY</u>	
WATER SAMPLES	WATER QUALITY PARAMETERS, MICROBIOLOGY

position occurring downstream of Tract C-b in areas with mud and clay substrate.

ARCHAEOLOGICAL STUDIES

Archaeological studies to determine the general level of historic or archaeological significance of Tract C-b have been completed by Dr. Calvin H. Jennings. In addition, each individual area in which specific exploration activities have been planned has been inspected by Dr. Jennings, prior to the initiation of any ground disturbance.

Three areas on-Tract and two off-Tract were found to contain items of archaeological or historic interest. None of these areas were found to be endangered in any way by planned exploration activities, and none of them were judged to be of the caliber of sites which would be eligible for inclusion in the National Register of Historic Places; they consisted primarily of scattered flakes, burned bone, a projectile point, various flakes and fragments, and the remains of an abandoned cabin.

SOIL SURVEY AND PRODUCTIVITY ASSESSMENT

The soil survey is designed to (1) map soils for the Tract and a surrounding area; and (2) to perform a number of tests on samples taken from representative soils. These tests include several physical properties and numerous chemical properties.

Secondly, the productivity assessment is designed to determine the ability of soils found on Tract C-b to support plant life. Plants will be grown on the various soils and examined for germination rate and productivity of vegetative matter.

The soil survey work is being coordinated with the Soil Conservation Service on the establishment of soils series for Tract C-b. Greenhouse studies for productivity assessment are underway in Woodward-Clyde laboratories, located in San Diego, California.

MICROENVIRONMENTAL PROGRAM

A program of microenvironmental study has begun in order to obtain data on certain physical parameters of the surface environment. Ball Brothers Research Corporation was contracted to supply the instrumentation. The stations are operated by C-b Shale Oil Project personnel. These stations are installed in each of the four major vegetation types: chained Pinyon-Juniper, Pinyon-Juniper, Valley Bottom Sagebrush and Plateau Sagebrush. The stations record wind speed and direction, air temperature, litter temperature, relative humidity, solar radiation, soil temperature, soil moisture and precipitation. It is felt that the data obtained will be helpful in the design of the required rehabilitation program.

FISH AND WILDLIFE MANAGEMENT PLAN

A Program Statement outlining the areas to be addressed in the Fish and Wildlife Management Plan has been drafted. This Plan will be prepared utilizing basinwide data, historic data, and biological baseline data which is being collected at the present time. The C-b Shale Oil Project environmental staff is working closely with State and Federal agencies presently engaged in the practice of fish and wildlife management in the Piceance Basin area, and is making certain that our plans and theirs are closely compatible.

SCENIC VALUES PROGRAM

The Lease Environmental Stipulations require that consideration of existing aesthetic values be given in all planning, construction, reclamation, and mining operations, and call for minimization of visual impact.

In order to meet these Stipulations, the type and quality of scenic resources which exist in the Tract C-b area, as well as the relationship of these to the overall scenic resources of the surrounding area are being considered.

A photographic history of the Tract, which is an ongoing project, will provide documentation of changes in scenic resources.

SURFACE GEOLOGY

The C-b Shale Oil Project has contracted with Amuedo & Ivey, consulting geologists and engineers, to map geologic features on and near the Tract. The firm will identify and analyze all fractures and faults, if any, as evidenced by stream channel orientations and rock outcrops.

DENDROCHRONOLOGY AND DENDROCLIMATOLOGY STUDIES

This program, being undertaken by Woodward-Clyde, is designed to assess significant trends or cycles in past climatic conditions. The study involves the analysis of growth-ring increments in Pinyon Pine. Three stands of Pinyon Pine have been cored, tree-rings measured, and a chronology of these rings prepared. The tree-ring measurements, when dated and matched with available climatic records, have been computer analyzed to identify any significant climatic trends and cycles. Present and future trends and cycles can be inferred from this information.

REVEGETATION PROGRAM

The revegetation plan for Tract C-b is intended to rehabilitate lands disturbed by the development of shale oil resources on Tract C-b in a manner consistent with good ecological practices, economic feasibility, and practical land use considerations.

The Revegetation Program for Tract C-b has four essential criteria by which to reach its goal:

1. Erosion control and surface stabilization;
2. Support of wildlife;
3. Accommodation of natural successional events in vegetation which will lead to a self-sustaining plant cover.
4. The development of revegetation and rehabilitation procedures consistent with advances in the art and the application of biological information gathered during the baseline period.

The program schedule is divided into two phases; some overlap exists between the two:

1. Stabilization and establishment of vegetation on sites disturbed by exploratory work;
2. The revegetation of spent shale disposal piles.

The first of these phases is an immediate action. The second phase is a long term function requiring a full analysis of past and on-going research and the possible implication of new research.

Significant to both of the revegetation phases is information which will be obtained from the baseline studies being done on Tract C-b. Data from a number of these studies will aid in the development of site

potentials. The baseline programs which interface with the Revegetation Program include vegetation succession studies, plant community studies, studies on the utilization of vegetation by wildlife and livestock, and geology studies. Particular attention will be given to the revegetation work done by Colony Development Operation in Parachute Creek and to the studies done by Professors William Berg and Philip Sims at Colorado State University.

Revegetation of Soils Disturbed During Exploration and Development

Major site types requiring revegetation of disturbed soils include abandoned drill pads, access roads, and other cleared support sites. The revegetation of these sites follows more conventional criteria than processed shale disposal sites. A list of potential species (Table 7) has been developed using the evaluation of the Surface Disturbance Plot set up on Tract C-b in 1972 by the Colorado Department of Natural Resources, (Table 8). The species to be used will be finalized by field checks and correlation with other site data from the vegetation baseline studies.

All vegetated areas will receive regular, systematic evaluation for species performance. This will allow us to better define the species to be used in future projects, conduct successional studies to determine the dynamics of the seeded plots, and conduct invasion studies to determine the function of the interface between the seeded plots and the native vegetation.

TABLE 7

RECOMMENDED SEED LIST FOR SURFACE DISTURBANCE AREAS ON TRACT C-b

<u>GRASSES:</u>	<u>lbs/acre</u>
Thickspike wheatgrass	1
Crested wheatgrass	1
Intermediate wheatgrass	2
Intermediate wheatgrass	2
Western wheatgrass	1
Slender wheatgrass	1
Pubescent wheatgrass	2
Mountain brome	2
Indian ricegrass	1
Needle-and-thread	1
 <u>FORBS:</u>	 <u>lbs/acre</u>
Utah sweetvetch	$\frac{1}{2}$
Palmer penstemon	$\frac{1}{2}$
Gooseberry leaf globemallow	$\frac{1}{2}$
 <u>SHRUBS:</u>	 <u>lbs/acre</u>
Mountain mahogany	2
Stansbury cliffrose	2
Antelope bitterbrush	2
 TOTAL	 <hr/> 21 $\frac{1}{2}$

TABLE 8

RESULTS OF EVALUATION OF SURFACE DISTURBANCE PLOTS
(COLORADO DEPARTMENT OF NATURAL RESOURCES) ON TRACT C-b

<u>SPECIES</u>	<u>RATING*</u>
Yellow sweet clover	fair
Thickspike wheatgrass	fair
Palmer penstemon	v. good
Western wheatgrass	fair
Basin wildrye	poor
Alfalfa	poor
Bluegrass	poor
Siberian wheatgrass	good
Mountain brome	good
Burnet	poor
Intermediate wheatgrass	v. good
Crested wheatgrass	good
Skunkbrush	poor
Salina wildrye	poor
Pubescent wheatgrass	v. good
Antelope bitterbrush	fair
Duraz hard fescue	fair
Intermediate wheatgrass	v. good
Smooth brome	fair
Alkali sacaton	poor
Indian ricegrass	fair
Bent grass	poor
Gooseberry leaf globemallow	good
Mountain penstemon	fair
Meadow brome	fair
Utah sweetvetch	good
Cliffrose	v. good
Mountain mahogany	fair
Desert bitterbrush	good
Tall wheatgrass	fair
Needle-and-thread grass	good

*Rating Factors

(growth, vigor, stand density)	Very Good
"	Good
"	Fair
"	Poor

Form 1279-3
(June 1984)

BORROWER'S CARD

DATE LOANED		BORROWER

USDI - BLM

